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ABSTRACT

Knowledge of results (KOR) is most frequently cited as the reinforcer in self-instructional systems. The printed answer in a programmed text, for example, is supposed to reinforce the response the student emits previous to observing that answer. Some other possible reinforcers are briefly discussed in this paper before the literature on KOR in self-instruction was selectively reviewed. The review was organized as a search for evidence that KOR might appropriately be called a reinforcer. Studies comparing programs with and without feedback were examined; the weight of evidence from these global studies was that feedback did not enhance learning, as measured by immediate post-test scores or by retention tests. In at least one case there seemed to be a decrement in performance traceable to the presentation of feedback. Studies in which "schedules of reinforcement" were varied similarly failed to show effects that would be expected if KOR were acting as a reinforcer. One major study involving delay of KOR did report the effect expected when delivery of a reinforcer is delayed. Other studies on delay do not replicate this finding. Finer grained analyses of student behavior and KOR begin to reveal specific conditions under which KOR seems to be acting as a reinforcer. (Author/AMM)

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KNOWLEDGE OF RESULTS AND OTHER POSSIBLE REINFORCERS IN SELF-INSTRUCTIONAL SYSTEMS

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KNOWLEDGE OF RESULTS AND OTHER POSSIBLE REINFORCERS IN SELF-INSTRUCTIONAL SYSTEMS[1]

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The knowledge of results literature was reviewed. It was concluded that printed answers in programmed texts do not automatically or globally function as reinforcers. Conditions in which information on one's learning performance becomes reinforcing were identified for future research.

An important contributor to the technology of education has been reinforcement theory, or popularly, "Skinnerian Psychology." Therefore, discovering, making explicit, and developing reinforcers in learning situations might well be a major area of concern to the technologist.

Though this paper concentrates, in a sense, on the search for reinforcers it is recognized that unsystematic contingency setting can, even with the most powerful reinforcers in hand, result in poor learning. B. F. Skinner (1968) points out that "...it is not the reinforcers which count, so much as their relation to behavior. In improving teaching it is less important to find new reinforcers than to design better contingencies using those already available." Nevertheless the explication of available reinforcers seems a necessary step in developing more effective contingency management in learning.

Special attention should be paid to reinforcement by those engaged in examining and designing self-instructional systems. Traditional reinforcers in education are often intimately tied up with the teacher/classroom system. The teacher is more than an exposer of material; sometimes he mediates reinforcers (e.g., reports activities to the principal, seats dyads and triads of students in certain places). At other times he directly administers the reinforcers (e.g., praises one student and applies the ruler to the hand of another). The designer who eliminates the teacher from his system is removing a reinforcing agent who has at least the potential for setting up subtle contingencies and for varying reinforcers with the moment and the student.

This paper briefly discusses some potential reinforcers for self-instructional systems and then provides a detailed review of the literature relevant to one of them: knowledge of results.

Some Possible Reinforcers

Glaser (1965) suggests an empirical approach for determining reinforcers: "Reinforcing events must be determined on the basis of detailed analysis of appropriate subject matter and component repertoire relationships [p. 707]." But he proposes some "illustrative leads", starting

with an application of the Premack principle (Premack, 1959) which suggests that high probability behaviors can be used to reinforce behaviors which have a lower probability of occurrence. Glaser cites one example. In a learning situation "backward chaining" would allow the student to be reinforced with the high probability, i.e., first and better learned behavior when he emits a previous step in the chain. Thus, teaching the student Step C allows it to be a reinforcing event for emissions of Step B when it is being learned. A variety of other educational applications of the principle have been demonstrated (see, for example, Osborne, 1969).

Manipulation or demonstrations of mastery or competence have often been cited as reinforcers or, in other terminology, as strong motives (see, for example, White, 1959). Glaser suggests "overt control over the environment" as a second possible reinforcing event. Skinner (1968) has suggested a similar class of consequences be considered reinforcing. "Children play for hours with mechanical toys, paints, scissors and paper, noise-makers, puzzles--in short, with almost anything which feeds back significant changes in the environment and is reasonably free of aversive properties. The sheer control of nature is itself reinforcing [p. 20]."

Many self-sustaining tasks, such as science learning kits or educational construction toys, seem to have this feature. Self-instructional materials might provide the chance to manipulate materials either during learning or as a consequence of successfully completing a learning assignment. Moore and Anderson (1968), Gotkin (1966) and others have leaned heavily upon the reinforcing effect of manipulation to sustain the learner's behavior in their "responsive environments."

Discovery, curiosity and exploration which have often been pointed to as reinforcers or motives seem to be similar to the events just discussed. For instance, one of the supposed benefits of the "discovery learning method" is the sustained interest and motivation generated by the activity of discovering. (In all cases being cited here, the specific and detailed evidence is lacking to support the contention that a certain class of events is reinforcing. No attempt is being made here to validate claims; this is merely a catalog of proposed and potential reinforcers for self-instructional systems.)

Self-instruction may be narrowly interpreted to mean "teacherless." In that case social reinforcers other than those mediated by a teacher might be considered. For example, the Human Development Institute (1966) has produced dyadic programs (involving two learners). A self-instruction problem solving course for teachers (Geis, et al., 1969) includes exercises which utilize two teachers interviewing each other, guided by checklists in the text. The "probes" which are an important part of a recent textbook (Ferster & Perrott, 1968) require two students cooperating on the exercises. In such cases as these it is certainly possible that the generalized reinforcers provided by another person may sustain student

participation in the learning tasks. Furthermore specific reinforcers supplied by the partner (e.g., "Now you're doing it correctly") may more precisely control learning. (In descriptions of his partially self-instructional system, Keller has stressed the reinforcing effects of peers who act as student "proctors." See Keller, 1967, pp. 17-19.)

Extrinsic reinforcers ranging from the omnipotent M and M candy to points, tokens, and toys, have been used as reinforcers in many behavior modification studies and recently have been used in connection with self-instructional materials (see Berman, 1967; Smith, et al., 1969; Sullivan, et al., 1967). Systems for reinforcer delivery, more elaborate than those generally present in a text or kit, are usually required when such reinforcers are used. Either a human banker or some thiefproof equipment may be called for.

Progress itself has been proposed as reinforcing: evidence of moving toward a goal may be sufficient to sustain the learner. Progress is defined a bit more specifically by Taber, et al. (1965). "Knowledge alone of the fact that he is performing correctly may be a less effective reinforcer for the student than being permitted to engage in further and more complex activity....Being able to move on, to get into and discover the fine details of the subject matter without being incorrect, frustrated, or punished for being wrong may be the most potent reinforcing consequence in a programmed instructional sequence [p. 10]." Record keeping and progress plotting is common among behavior modifiers and has been incorporated into a number of self-instructional systems.

Aversive stimulation has not been extensively explored either in the basic research literature of psychology nor the technology of education. Yet the continuing evidence from everyday living suggests it is a frequent and powerful controller of human behavior. Some branching programs incorporate verbal punishers in the text. Students who choose incorrectly on a multiple choice frame may be directed to a page which contains a verbal rebuke. It has been pointed out elsewhere that "...finding a short cut or an easier way to emit a certain response is also reinforcing for most learners [Taber, Glaser & Schaefer, 1965, p. 27]." Some experimental evidence supporting this modern restatement of the Law of Least Effort is available. The results of one small study (Geis & Knapp, 1963) indicate that avoidance of additional work in a program, i.e., reduction of the number of frames the student is required to do, can serve as a reinforcer.

Possibly aversive stimulation is involved in the concept of reduction of tension or of uncertainty. Many people (see Berlyne, 1960) have suggested this as a major variable in the control of human behavior, especially human learning. A learning situation, it is contended, should produce a slight rise in tension followed by tension reduction after the response is emitted. (Seemingly related is the concept of closure or completion advanced by Gestalt psychologists.) The authors of a large reading program for children (Smith, 1964) have informally commented on the importance of this wavelike tension profile in self-instruction.

Presumably they have tried to design their programmed materials accordingly. Less precisely controlling student uncertainty but probably based upon the same assumption are those programs which the authors claim have error production purposely built into them in order to "maintain student interest."

The most frequently cited reinforcer in the literature on self-instructional systems, especially programmed instruction, is knowledge of results (KOR). Almost all published programs, as well as innumerable articles and texts cite as one of the rules of programming: "Include the correct answer in the program in order to reinforce the learner."

The remainder of this paper will be devoted to a discussion and review of the literature on this, the most popular, candidate for the role of reinforcer in self-instruction.

The phrase "knowledge of results" at first glance seems self-explanatory and specific. However, it refers to a great variety of environmental changes or stimulus presentations ranging, in instruction, from indicating to the learner that he is correct to providing elaborate, informative, corrective materials when he has made a mistake. "Non-verbal" feedback consequences are as varied. A student might discover how well he has assembled a piece of apparatus by plugging it in and trying it out; he might test a formula he has invented by going into the lab and blending the ingredients; he might observe a computer simulation of his patient's vital signs before, during, and after the treatment he has proposed; he might watch a model of the bridge he has designed displayed on a cathode ray tube and undergoing stress from traffic and winds. (Some feedback consequences are non-verbal but do not occur "naturally" as a consequence of the student's previous performance. These have already been mentioned under the heading of extrinsic reinforcers.)

In fact, any consequence discriminable to the learner and regularly related to his previous performance can be designated KOP. A child working on a teaching machine which produces a green light each time he makes a correct response, is getting feedback. The child who is told that he may go to the playground when he finishes his assignment is also in a feedback situation. So is the student who, after he gives his answer in class hears the teacher say, "Well, yes. But does anyone else have a different answer to suggest?" And so is the child who hears increasing giggling from his peers as he works the problem on the blackboard.

But KOR usually means something more specific than that. Some performance consequences are reinforcing in and of themselves. Suppose that a child is permitted to play with a toy when he has finished spelling five words correctly. Playing with the toy is a reinforcing activity. It can be used to strengthen a variety of behaviors; it is not uniquely tied to the task at hand. Contrast it with a procedure in which, after spelling each word the student is shown the correct spelling of that word.

Permission to play serves the same informative function as the correctly spelled words but it is also reinforcing "in its own right."

A further distinction has to do with the specificity of contingencies. Usually KOR refers to consequences immediately after each response. It is often contingent upon approximations to a more complex final performance. Other "reinforcers" are usually contingent upon completion of a larger task (e.g., an assignment rather than a frame in a program).

KOR is often a mediating system: a means to an end. The child who is promised permission to play when he has finished the assignment may also have been told he was correct (KOR) after each word or problem.

It is sometimes said that being correct or "knowing you are right" is reinforcing in itself and need not be linked to other reinforcers. This claim for an autonomous status of KOR is particularly common among educators who are concerned that the use of other reinforcers either instead of or in addition to KOR not only weakens the effect of "the joy of learning for its own sake" but also smacks of immorality and bribery. We will not pursue questions concerning what particular type of reinforcer KOR may be but will confine ourselves to discovering any evidence that it is a reinforcer at all.

We will limit the use of "KOR" to those cases in which the major consequence of the response is information about the learner's own performance. We are excluding all of the potential reinforcers dealt with earlier in the paper which have demonstrable reinforcing effects outside of the task situation.

So far we have run the risk of appearing anti-semantic by using a variety of terms interchangeably: feedback, confirmation, reinforcement and knowledge of results.

Each of these terms has its drawbacks. Feedback, for example, suggests continuous guidance and an adjustment to the responses producing the feedback; the speedometer on an automobile illustrates feedback better than a bit of programmed text. Michael and Maccoby (1961) have noted that "the term 'feedback' and other related expressions...are, in a sense, misnomers, as applied to the procedures of the kind used here (providing answers in a programmed situation) in that the information is the same, from a stimulus point of view, regardless of what response the subject has made during practice. In the knowledge-of-results procedure, as traditionally applied to practice of skills, by contrast, ...feedback depends upon the extent and kinds of errors just made in practice. In both instances, however,...'feedback' does provide a basis either for recognizing and correcting errors made in practice [footnote, p. 252]." In the context of self-instructional systems, the word "feedback" might more appropriately be used to refer to response consequences in computer-based branching programs.

"Confirmation", on the other hand, suggests that a correct response preceded answer-observing. Though an error can, in a sense, be confirmed, general usage indicates a positive relationship between response and confirmation, making the word synonymous with "verify" and "validate."

"Reinforcement" presupposes the relationship between answer and response that is being questioned in this paper: the purpose of this paper is to explore the possibility that the presentation of an answer contingent upon a student response is a reinforcer.

"KOR" has a slight mentalistic tinge (i.e., does the word "knowledge" indicate some mental activity of the student?). Nevertheless it seems like the least ambiguous term and will generally be used throughout.

Behind the proposition that KOR (e.g., the printed answer in a program) is a reinforcer lie many assumptions about the student's interaction with that answer.

Suppose that a student is working his way through a programmed text which supplies the correct answer in printed form next to each item. That printed answer cannot have an effect on the student unless he comes in contact with it. (Programmers have been accused alternately of being too artistic and too scientific but no one has yet charged them with being metaphysical.) Observations of students working through programmed materials, to be discussed at length later, suggest that the learner does not always look at the printed answer. Providing printed answers then, is not reinforcing. In order for an answer to become so, the student must look at, and respond to the print.

Suppose the student does just that. Still a variety of conditions can occur. The prime reinforcing effect of the printed answer is likely to depend upon the student being able to discern how correct he was. In many programs the student matches his answer to the text's. The matching is not always a trivial matter. Given a program in writing Chinese symbols, or an audio-lingual Spanish program the student may have a difficult time telling whether or not his product "matches the model. (In a non-language learning program a similar problem occurs when the author slyly adds the phrase "...or synonymous answer" to his answer.) Indeed, paradoxically, some second language learning programs require the student to make such discriminations as confirmation before he is adequately taught to do so. The result may well be that the student accepts his own erroneous responses as correct. (For further explication of this point see Geis (1965), pp. 24-25.)

But suppose that all of those pitfalls are overcome. The student works through a printed program, looks at and matches a printed answer with his own and then finds out that his answer is incorrect. Skinner (1962) points out that "While we learn with knowledge of results may be preferable to learning without such knowledge, knowledge that one is consistently doing poorly cannot be said to be reinforcing [p. 9]." (The

student who, by observing answers in a program, repeatedly discovers that his own answers are erroneous and who nevertheless continues to observe the printed answer might be suspected of masochism.)

This short discussion indicates that the easy phrase "the answers are reinforcing" ought to be approached with caution and accepted only tentatively until a better definition and more evidence are provided. Such conservatism will be reinforced by an examination of the relevant research literature.

Review of the KOR Literature

Most studies (including those reviewed here) are not directly aimed at investigating whether or not answers are reinforcers. The question usually being attacked is a broader one: Does feedback in some way affect performance during and after self- (programmed) instruction?

Feedback may affect performance, but technically not be a reinforcer, serving some other function in learning. Goldbeck and Briggs (1962), for example, suggest that feedback "...may provide information concerning the adequacy of responses made, may serve as a reinforcement and reward for responses, may have a motivating effect on performance, may be used to direct the next step to be taken in the learning program [p. 184]."

Just as it might be mistakenly identified as a reinforcer when it was not, KOR could act as a reinforcer for behaviors not being measured by the experimenter and so be overlooked. For example, looking at an answer in a programmed text may be reinforced by "seeing it." But if such answer-observing does not lead to better post-test performance (and post-test performance is being measured in the study), one might erroneously conclude that KOR does not function as a reinforcer at all.

In this paper feedback studies will be reviewed with an eye to the more specific problem: Is KOR a reinforcer in self-instruction? The review is restricted almost entirely to self-instructional situations. It has already been pointed out that there is a large literature on KOR which represents research using other than programmed instructional materials. (For a broader survey, the reader should consult a recent comprehensive book (Annett, 1969) which deals with a great variety of tasks involving feedback.) While such research seems occasionally to throw light on KOR as a variable in learning, often the situation differs so much from self-instruction that extrapolation is unjustified.

Feedback vs. No-Feedback

(As Annett (1969) points out, intrinsic feedback is unavoidable; it occurs as part of the performance itself, e.g., hearing your own overt vocalizing. "No-feedback" means no experimenter-supplied feedback.)

There is ample evidence that under some circumstances feedback affects performance. However, the results with regard to programmed instruction are somewhat ambiguous.

Feedback enhances learning. In an investigation of the relationship of test anxiety and feedback in programmed instruction, Campeau (1968) found that feedback was a significant variable in the performance of grade-school girls. Post instructional test scores were higher for those high anxiety girls who had feedback during learning. Low anxiety female students who had no feedback had higher post-test scores than high anxiety females who had no feedback. (No significant differences were found between low and high anxiety students under feedback conditions.) Male students showed no similar regularity.

In two studies by Anderson, et al., in press, a computer-based system was used by a large group of subjects (Ss) to learn a lesson on diagnosis of myocardial infarction. Ss receiving KCR showed clear superiority on the criterion tests and made fewer errors within the program itself.

Using materials that might be considered "programmed", Wittrock and Twelker (1964) found an interesting relationship between KCR and rules: one similar to that emerging from the literature on prompting and KCR. While rules alone proved most effective in teaching Ss to decode ciphered sentences, KCR was especially useful when rules were not supplied. It did not add to teaching effectiveness when supplied in conjunction with rules, supporting the authors' content on that "KCR [the abbreviations KCR, KCR and KR are equivalent] enhances learning retention, and transfer, when the information it contains is not overtly redundant...[p. 11]."

A number of studies recently published on the issue of feedback vs. no-feedback (e.g., Alter & Silberman, 1967) seem to me only tangentially relevant. They all involve presenting a program which has available both response blanks to be filled in by the student and printed answers with the same program in which the response blanks are already printed in the text and, of course, no "answers" are available. Under the latter condition, since no particular response is specifically called for, it is logically difficult to even understand the reinforcer (i.e., feedback) for it is being withheld. This view does not imply that study of text reading does not enhance learning; some sort of "self-reinforcement" indeed may take place, a viewpoint held, for example, by Krumboltz and Klausmeier (1965). However, a better test of the question involves calling for a response and then confirming or not confirming the emitted response.

Feedback does not enhance learning. The studies cited above constitute the major evidence used in stating the importance of feedback in programmed instruction; the evidence is specious. Studies supporting its efficacy are more numerous.

Ripple (1963) compared teaching material in a variety of forms including a standard programmed text with and without "reinforcing feedback." The author concluded (from a comparison of criterion test scores of the feedback and no-feedback groups) that there was no differential learning or retention.

An oft-cited study by Feldhusen and Birt (1962) used a short program presented to college students. The authors concluded that the no-confirmation groups did not significantly differ from the confirmation group.

Moore and Smith (1964) also reported no differences on the post-test between KOR and no-KOR groups of college students who used a version of the Holland-Skinner psychology program. The experimenters tried a variety of feedback conditions (KOR alone, KOR plus pennies, KOR plus light), none of which seemed to affect learning significantly. However, errors within the program were fewer for the KOR groups.

In an earlier study by the same authors (Moore & Smith, 1961) a spelling program for 5th- and 6th-grade children was presented with and without confirmation. Again, there seemed to be no difference in terms of achievement test results between the two treatment groups.

Hough and Revsin (1963) also reported no effect of KOR when it was used in a 555-frame college level program. Echoing a recurrent theme found in this literature, they state: "The program used in this study has a low error rate. When students 'know' that their response is right, and thus presumably reinforce themselves, it would seem reasonable that further confirmation in the form of a reinforcement frame would be redundant (p. 290)."

Becker (1964) used a 180-frame program on time-credit loans with a small group of adult learners. Though both KOR and non-KOR groups showed dramatic gain scores, the differences between groups did not prove to be significant.

While findings which indicate no effect of feedback are disconcerting, even more damaging would be evidence that feedback actually hindered performance. Swets, et al. (1962) report such data. Ss were taught to identify multidimensional, non-verbal sounds utilizing a computer-based teaching system. Detrimental effects of excessive feedback were demonstrated when the performances of feedback and non-feedback groups were compared.

Jacobs and Kulkarni (1967) used a program on gas laws with groups of high school students and a program on solving equations with groups of junior high students. The three experimental conditions were: regular program, a program with KOR omitted, and the regular program with the order of some sections inverted. Although the junior high no-confirmation group averaged more than twice the number of errors in the program (a finding consistent with that of Krumboltz and Weisman, 1962, see below), their post-test scores were not significantly different from those of the other two groups. Within the high school groups errors were again high for the no-confirmation group. There was little evidence of a related effect of these high errors on post-test scores. This trend in error data did not hold for the other high school group although it also showed high post-test scores. In contrast to the results obtained with junior

high Ss, the post-test differences among groups in both high schools were significant, with the regular program group learning the least. It may also be noted that the no-confirmation group generally showed a more positive attitude toward the program materials.

The results in the literature, then, are conflicting and puzzling. A number of design and interpretation problems may lie behind some of the ambiguity. One suggestion of particular relevance stems from a study by MacPherson, Dees, and Grindley (1948-1949). In presenting the results of the study of skill learning they suggest an interpretation which has implications both for those theorizing on the effects of feedback and those reviewing or designing research in the area. The authors propose that the importance and function of KOR varies with the stage of learning. In the initial stages of learning, they contend, the directive or informational effect of KOR is important; after performance has stabilized the "incentive" function of KOR assumes greater importance; finally when proficiency has reached a high level, overt, formal KOR seems to be of little value. This does not seem to be incompatible with the view presented earlier by Wittrock and Twelker and others; that the effect of KOR varies with its redundancy.

A second suggestion relates item difficulty and the reinforcing effect of confirmation.

Holland (1965) points out after reviewing the confirmation literature that no difference between confirmation and non-confirmation is found when programs with low error rates are used. "On the other hand, studies which utilized high error rate materials tended to show an advantage in the confirmation group. Students' confidence in their own answers would not be great in such programs. "The relation between item difficulty and relative effectiveness of confirmation may be indicative of the nature of the reinforcer in the program. The reinforcer may be an answer known by the S to be correct either because he is told it is correct or because he was already confident of his answer [p. 91]."

Schedules of Reinforcement

One test of whether a particular consequence is, indeed, a reinforcer is to present it under various scheduling contingencies and observe whether or not predicted changes in behavior occur. A large literature on the effects of various schedules, on human and infra-human Ss, strongly suggests regular effects and a comparison can easily be made between the results of a new study and that literature. If a consequence thought to be a reinforcer fails to produce the expected results, its status as a reinforcer is questioned.

A technical difficulty which can assume critical proportions is present in many of the current studies in the programing literature. Data (to be presented later) suggest that learners rarely learn at all

available answers. This presents only somewhat of a problem when comparing no-feedback with feedback conditions. However, when schedule of reinforcement is the independent variable, one might well question whether, for example, "50% answers available" is equivalent to "50% of answers observed." In short: is the schedule of reinforcement to be defined formally: in terms of the number of answers available to the S, or functionally: in terms of the actual number of answers observed?

A second problem concerns the usage of the term "reinforcement." Traditionally, a schedule of reinforcement refers to the contingency involving a single operant class (roughly: "one kind of response"). However, the studies to be cited here involve "reinforcement" of classes of different responses. Thus, a 50% partial schedule does not mean that one half of the emissions of responses in a certain class are reinforced. Rather, it means that half of the answers were present and available in the program. In point of fact, if the answers are indeed reinforcers, each one usually is reinforcing a different response.

By way of preview it might be pointed out that the literature on schedules of reinforcement in programs resembles in one respect that reviewed in the previous topic: the findings of different investigators are in disagreement.

Studies Showing Schedule Effects

In 1965, Lublin (1965) studied a large group of college students in a programmed psychology course. Students were on schedules of reinforcement including no confirmation, 100% confirmation, fixed ratio 50%, variable ratio 50%. She found that the VR 50% and the No-Reinforcement group scored higher on the criterion test than did those students under the continuous reinforcement treatment. The author suggests that "omission of the answers may have caused the subjects to look for confirmation of their responses in succeeding frames [p. 299]." Presumably, this is tied somehow to better attending and, consequently, improved learning. Conversely, the continuous reinforcement group may not have engaged in these beneficial searching behaviors and may have learned little from the frames. In addition, Lublin suggests that the post-test more closely resembles the no-answer program so that the regularly reinforced students may have been handicapped when faced with it after a continuous reinforcement format in the program itself.

Krumboltz and Kiesler (1965) propose that in a low error rate program response requests without answers provide the occasion for self reinforcement. Using a 177-frame program on educational test interpretation, they found that the 100%, 20%, and 10% reinforcement groups did show a difference in behavior. The partial reinforcement groups clearly made more errors in the program and on the immediate post-test. Post-test scores decreased as the number of confirmations and number of response requests decreased, a finding contradicting Lublin's. The 10% response request

and confirmation condition had the least frame errors, data similar to that obtained in the earlier study by Krumboltz and Weisman (1962). Time to complete the program decreased as response requests and confirmations were removed. The authors suggest that the findings of the study support their hypothesis, though perhaps the measures of "self-reinforcement" are too few to be persuasive.

In a study by Moss and Neidt (1969) the problem was looked at in the context of information theory: both KOR and amount of certainty were varied. University and high school students served as Ss and a short (42-frame) adjunct style program in insecticides was used. Decrements in learning were found both when items of information were omitted (i.e., lower percentage of KOR) and when uncertainty was reduced. The authors conclude that the effectiveness of KOR is intimately related to the degree of uncertainty: KOR is useful and important when uncertainty is high.

Studies Showing No Schedule Effect

Glaser and Taber (1961) investigated the effects of partial "reinforcement" using a symbolic logic program for high school students. None of the four experimental groups (100% reinforcement, 50% fixed ratio, 50% variable ratio, and 25% variable ratio) differed significantly from each other on the criterion test. The authors suggest that the reinforcing effectiveness of feedback may depend upon the age of the student, specific subject matter, IQ, and probability of correct response.

Scharf (1961) used a symbolic logic program with high school juniors and 50% and 25% variable schedules and 100% and 50% fixed schedules of confirmation. No significant relationship was found between schedules and post-test errors, program errors, or post-test time to completion. The only important difference among groups seemed to be that the 50% variable schedule group took the longest time to complete the program.

Krumboltz and Weisman (1962) also found no difference in criterion test scores for variable vs. fixed ratio schedules nor for 0%, 33%, 67%, and 100% schedules. There was no interaction effect either. However, students made fewer frame errors in programs with more confirmation.

Driskill (1964) used Air Force men on a 52-frame program in powers and roots of numbers. Half received 40% or 100% feedback. No significant difference was found between the gain scores for the two groups.

Rosenstock, et al. (1965) used four different schedules of feedback with a mathematics program: 100%, 70% fixed, 70% variable, and 0%. Partial knowledge of results did not seem to enhance learning, but again, fewer program errors occurred under conditions of increased KOR.

Using 4th-grade students, Blank and Ryan (1967) investigated schedules of reinforcement with a short program on the English money

system. The program was chosen for its difficulty, having a predicted high error rate. The study, therefore, attempted to answer criticism of previous studies to the effect that the failure to find differences due to various schedules of reinforcement was a result of using low error programs. (As noted earlier, again and again suggestions are made in the literature that "confirmation at the frame level may have little effect on student motivation except in situations when the student has real doubts about his answer as in unusually difficult frames.[Taber, Glaser, & Schaefer, 1965, p. 92]."") In this study no significant differences were found among post-test, gain, or error scores for the various groups (100%, 67% VR, 33% VR, 0%, and "logical confirmation", this latter group having answers supplied on the terminal frame for each concept). The only significant difference was found in a sub-group taught by teaching machine. For that group, the difference in gain scores between the 100% and the 67% treatments was statistically significant.

The authors, in their introduction, state "By and large the conclusion suggested by (studies on confirmation) is that either (a) it is incorrect to regard confirmation in programmed instruction as equivalent to reinforcement as used in the sub-human context, or (b) these studies have failed to meet the necessary conditions that there be little chance for inter-frame cueing. If the latter conclusion is true, then varying schedules of confirmation in the form of knowledge of results should manifest their differential effects where the probability of error response is high.

"A further possibility...is that the conceptual material found in most programmes does not lend itself to random partial reinforcement [p. 13]."

On the basis of their analysis of the literature and the findings of their own studies, the authors severely question the traditional observation that confirmation is a reinforcer. The results of a later, more elaborate, study (Pysh, et al., 1969) again question the role of confirmation as a reinforcer. In that study the authors conclude: "In summary, it would appear that the pivotal assumption that programmed instruction's effectiveness derives from the explicit provision of KR in the form of a confirmation frame with which the learner compares his antedating response, requires a reappraisal [p. 62]."

Delay of Confirmation

Another probe to discover the reinforcing effects of any consequence involves delaying the proposed reinforcer after a correct response is emitted. A large literature exists which, though not entirely consistent, strongly suggests that delaying the presentation of the reinforcing consequence reduces its effect on the behavior upon which it has been made contingent. This literature has, for the most part, involved infra-human

Ss (although a fairly large sub-set concerns the behavior of retarded children). Evidence for delay noticeably affecting the performance of humans is less solid than evidence of such effects with lower organisms. (See, for example, Renner, 1964)

Much of the research that seems to be at all relevant to the issues raised in this paper involves feedback in test situations or in situations involving memorization of discrete associations. These results are not consistent nor always clear. Sometimes immediate feedback seems to be more effective than does delayed feedback (see, for example, Sassenrath, et al., 1968); sometimes delayed feedback seems more effective, especially when long-term retention is being measured (see, for example, Sassenrath & Yonge, 1969; Sturges, 1969; Brackbill, 1964).

Delay produces effects. A few studies are directed specifically at the programmed instruction situation. Evans, Glaser, and Homme (1962) investigated delay using a program in symbolic logic. Delays in confirmation (ranging from 30 sec. to 5 min.) seemed to have only a little effect on criterion performance. The authors suggest that when the correct response is highly probable, the effect of confirmation may be minimal, a theme we noted occurring elsewhere in the confirmation literature.

A study by Meyer (1960) involved presenting a 19-lesson program on Latin prefixes in English to 8th-grade students. One group had immediate feedback (answers were available in the text) and another group had delayed feedback (no answers were available in the text). The answers for both groups were "corrected" and returned to the student by the experimenter the next day. Students in the delayed feedback group committed more errors in the program. The author suggests a lack of potential for self-correction in the form of the program used by this group. Repetition of previous errors by these students, therefore, probably accounted for their poorer performance. Comparison of post-test scores for these two groups revealed a difference in the predicted direction just short of significance ($p = .06$). The immediate feedback group showed higher scores.

The author concludes: "It was hypothesized that immediate confirmation of correct responses and disconfirmation of incorrect responses would lead to superior acquisition. The hypothesis was supported by the data [p. 69]."

Delay produces no effect. Siegel (1965) used a modification of the symbolic logic program used by Evans, with college students. He found a significant interaction effect of delay of feedback (i.e., time from response to feedback exposure), and post-feedback delay (i.e., time between end of feedback exposure and presentation of next frame) on program errors but not on criterion scores. There were more program errors in the feedback-delay, no post-feedback delay condition and in the no feedback delay, post-feedback delay condition. However, more importantly, delay of feedback did not produce a significant main effect on the program or on criterion error scores.[4] (Delay in this study was short: a sec. in length.)

Other Kinds of Evidence

A general observation can be made at this point: the evidence is weak that confirmation is a reinforcer. The results reviewed are at least inconsistent; if there is a trend it is toward showing no real reinforcing effect of feedback.

Some "secondary" generalizations do emerge from the literature. For example, students with less, or no, opportunity to view answers commit more errors in the program. This finding seems explainable in terms of those in confirmation groups being able to peek at answers and to correct their errors. When the opportunity to peek is controlled for, usually there is an increase in errors noted in the confirmation group. That error or peeking has any effect on learning (in terms of criterion test scores) is not at all clear.

It could be argued that the reinforcing effect of confirmation is subtle and that the experiments cited have not been sensitive enough to pick up an existing effect in terms of design or the measures of the dependent variables. Some suggestions have already been made about confounding or masking variables that ought to be considered. (For example, the argument has been repeatedly raised that the probability of correct response interacts with the effect of confirmation, an hypothesis to be returned to later.)

Organism Variables

Permanent or momentary organism-centered variables (e.g., anxiety, I.Q., sex, age, achievement motive) might confound experiments in which other variables are being manipulated. Assuming that the literature search made in the preparation of this paper was fairly comprehensive, one would conclude that the only extensive research on such variables has been conducted by Campeau whose work was reviewed earlier. A major variable in her research has been anxiety, specifically test anxiety as measured by the Test Anxiety Scale for Children. The author contends that accentuating the test-like features of the situation by omitting answers in the program should adversely affect high anxiety Ss. Furthermore, a comparison of high and low anxiety Ss under feedback conditions should reveal higher achievement scores for the high anxiety group (implying, in the context of this paper, that feedback may be reinforcing, or at least more reinforcing, to anxious students). The difference found in Campeau's studies were not significant for the male Ss. High anxiety girls did somewhat better, but not significantly better, on immediate post-tests than did low anxiety girls when both groups had received feedback in the program. High anxiety girls in the feedback group showed dramatically better gain scores than those in the no-feedback group. The evidence is not very clear, however, that feedback is more reinforcing to high than to low anxiety students.

Though a number of writers (e.g., see Taber, et al., 1965, p. 170) suggest that factors such as age, motivation, and I.Q. may well interact with feedback, little research has been directly aimed at investigating such relationships. (Though there is a small literature on student characteristics and programmed instruction, see, for example, Woodruff, et al., 1966.)

Task Variables

A second set of variables which might effect the status of feedback involves the task itself: the kind of task (e.g., motor skill learning as contrasted with verbal discrimination), the degree of interaction of the parts of the task (e.g., learning rote material in which the components have little interaction with each other vs. learning concepts which are related) or task complexity. For example, some pilot work by the authors (Geis & Chapman, 1970) utilizing a program teaching Russian script (i.e., the cyrillic alphabet) suggests that students are more likely to request feedback when the task requires production, in this case writing a letter, than when a discrimination alone is called for, as when the student is asked to choose the better of two letters. More generally stated: feedback might be more reinforcing when one is executing a complex motor coordination than when he is merely recognizing a correct item in a choice situation. This may be related to the idea that the probability of error interacts with the reinforcing effect of feedback, since the chance of making some error is usually increased when a chain of responses is called for, as in the case of production.

Kinds of Feedback

A third area might be called "Kinds of feedback." Certain types of feedback may, in an absolute sense, be more reinforcing than others, or may be more reinforcing under certain conditions. For example, given a two-choice discrimination task in a program frame, the student might be reinforced by an indication of "correct response", as a light going on after he emits the right answer. Failure to produce the "correct" signal is logically equivalent to producing an "incorrect" signal, in the two-choice situation. (There is some indication that feedback for right and no feedback for wrong answers is not completely equivalent to identifying the answer as right - wrong. However, generally speaking the feedback for correct responding in a two-choice situation seems to exhaust all the possibilities.)

At the other extreme might be a complex motor task. When learning to pronounce a French word or to write a Thai symbol, binary feedback limited to "correct" "not correct" may prove unhelpful/boring. On the other hand, a more elaborate feedback system (e.g., pointing to particular dimensions of the student's response which fail to meet criteria and providing a correct comparison model for him at the time) might be highly reinforcing.

"Kind of feedback" might also refer to varying contingencies of the same feedback, i.e., the same information. (Thus, in a study by Anderson to be discussed later [Anderson, et al., 1970], one group received answers only after they had made an incorrect response while other students received feedback only after they had made correct responses.)

Branching programs often provide elaborate and varied response consequences. In examining possible evidence for the reinforcing effects of various kinds of KOR it might be appropriate to include the branching literature. Unfortunately, there seems to be no research specifically directed to explorations of kinds of branches, number of alternatives in a branching system, etc.. (This seems a fallow area for research.) The assumption is commonly made that a branching program, especially a computer-assisted one, is bound to be superior to a more pedestrain linear program. In summarizing his review of the area, Holland (1965) noted no significant advantages had been demonstrated for branching programs. Two years later Anderson (1967) came to the same conclusion despite additional research that had been conducted in the intervening time. There may be advantages to branching; certain kinds of branching consequences may be reinforcing. But at present there is little evidence to that effect.

The research literature on kinds of feedback in programmed instruction is small but interesting.

Kind of feedback affects learning. Krumboltz and Bonawitz (1962) varied the form of confirmation by using their educational test construction program. The "isolation" approach involved presenting as feedback the word or phrase that was desired as a response. The "context" approach presented the confirming response by repeating the relevant part of the stimulus frame. The experimenters found no differences on a subtest of knowledge of technical terms, but a significant advantage was found for "context" confirmation on a sub-test of applications of test construction knowledge. The authors caution that the findings are for a small group of Ss. Nevertheless, there is a suggestion that kind of feedback may interact with the development of certain kinds of terminal behaviors and not others.

Gilman (1968) has investigated the effect of various kinds of feedback in a computer-assisted instruction system. He points out that "if there were no purpose to feedback other than to provide the student with reinforcement, statements such as 'you are correct' should prove equally effective as confirmation of a correct answer [p. 2]." University upperclassmen were taught 30 general science concepts by means of a CAI adjunct self-instructional system, using a multiple choice format. Various modes of feedback were used: no feedback; "correct" or "wrong"; feedback of correct response; feedback appropriate to the student's response; and a combination of the three latter modes. Students repeated items which were missed until a perfect run through was obtained. The no-feedback group

and the "correct" or "wrong" group performed less well on the program, making a significantly greater number of responses and requiring a greater number of iterations of the program in order to reach criterion. On the post-test, the combined feedback group scored significantly higher than did the others.

These two studies seem to suggest that more elaborate feedback may be more reinforcing, or at least more effective in some way, in changing student behavior. However, other studies do not support this hypothesis.

Kind of feedback does not affect learning. McDonald and Allen (1962) varied the kind of confirmation in a program which taught a game similar to chess or checkers. The variations in confirmation included: no response request and no confirmation; response request with correct response as confirmation; response request, correct response and an explanation of correctness or incorrectness as confirmation. The experimenters found no differences among groups on immediate and delayed criterion tests.

Bivens (1964) used a short program in elementary set theory with 89 8th-grade students. Confirmation was offered in simple and complex forms. The simple form was a presentation of the explicit desired response. The complex form was an example of a different but similar problem already solved. All students had the complex form of confirmation available. Those in the "simple" form condition were told to check the answers against the simple answers and merely read the other solved problems. Those in the "complex" group were instructed to search through the solved problem to determine if their own answerswere correct. There were no differences found between the groups on the criterion test after learning.

Anderson, et al. (1970) used several feedback arrangements involving a computer and a program on diagnosing myocardial infarction. In one experiment, using several groups, they presented the correct response (1) only after a correct response had been emitted, or, (2) only after a wrong response had been emitted, or (3) always, or (4) never, or (5) after a correct response but the S "looped" back to the same frame after the wrong responses. Criterion test scores were highest for the 100% feedback and the looped groups. The only group with significantly lower test scores was the no-feedback group. Of interest here is the fact that no significant difference was found between the 100% and the looped group, although the latter students underwent much more elaborate feedback procedures. Furthermore, there was no evidence in these studies that KCF functioned as corrective feedback. The group receiving KCR only when errors were made did not perform significantly better on the criterion test than the other KCR groups. Again, whatever reinforcing function KCR might serve was not established. The KCR-only-when-correct group performed at the same level as the other groups.

In a second experiment by the same authors, the 0 and 100% groups were again used. Various groups of Ss who always received KOR were exposed to one of the following additional variations: S was forced to repeat wrong frames until he made the correct response; after each of four sections (about 25 frames) in the program S repeated any wrong frames in the preceding section until he made a correct response; when he made an error S saw the frame and KOR for 15 sec; S was presented with frame and answer but was instructed to respond before looking at KOR. (This last group was similar to groups of students using programs outside of experiments and without mechanical presentation devices in that "peeking" was possible.) Again, the 100% group proved to have undergone the most effective procedure both in terms of reduced number of frame errors and increased criterion scores. And again, no difference in favor of the more elaborate feedback procedures was found in this study.

Melaragno (1960) investigated negative feedback using a set of 50 multiple choice items for teaching the names, uses, and meanings of five logic symbols. The material resembled programs of the day, having easy small steps. A small group of junior college students acted as Ss. Five ambiguous items with no correct answers were inserted to determine the effect of negative reinforcement on post-test score. Members of all groups were shown a green light after each response to an item in the program except for the five ambiguous ones. The green light indicated that the previous response had been correct. (S received the green light, "correct," signal even if he had made an error on the frame.) Following responses to the ambiguous items: Group I saw the green light after each response to the ambiguous items, which indicated they were correct. For this group the ambiguous items were spaced throughout the sequence. Group II saw a red light indicating responses to the ambiguous items were wrong. Again, the five items were interspersed throughout the program. Group III also saw "incorrect" feedback lights on the five items which were in this case massed at the middle of the total set.

All groups were given a 45-question criterion test upon completion of the learning sequence. Group III had lower post-test scores than the other two groups. The author concluded that some spaced negative reinforcement does not impair learning, but the massed negative reinforcement seems to.

Prompting and Cueing

In pursuit of the specific conditions under which confirmation might be reinforcing the literature on prompting was examined. The conjecture was one already repeatedly discussed in this paper: namely that the reinforcing function of KOR may depend in good part upon the probability that S emits a correct answer. Frames with a high degree of prompting reduce the chances that an erroneous response will occur and, therefore, confirmation following such frames should be minimally reinforcing.

There is a large literature on prompting versus confirmation, much of it involving non-programmed materials (e.g., Cook & Spitzer, 1960). A comprehensive review by Aiken and Lau (1967) examined three types of learning: verbal learning, perceptual learning, and signal monitoring. The authors conclude response prompting is as effective as, or is more effective than, response confirmation. (A possible exception, the authors note, is discrimination learning.) While cautious in their conclusions and extrapolations, the authors stress that one should neither ignore the potential importance of antecedent stimuli in controlling behavior and effecting learning, nor subsume all consequent, response contingent, events under the rubric "reinforcer."

From the literature, two opposing suggestions concerning prompting in programs emerge. The first is derived from paired associate learning studies in which the superiority of prompting over confirmation seems to have been established. Extrapolating to programmed materials from such data, one would recommend heavily cued frames. The second view (e.g., Margulies, 1968) suggests that over-prompting in a program, especially one involving non-rote materials, may reduce the effectiveness of learning since it eliminates searching, problem solving and some of the other (probably covert and assumed) behaviors that the programmer intended his student to engage in.

There are about half a dozen studies on the issue of prompting which do utilize programmed materials.

No Effect

Silberman, et al. (1961) used 61 teaching items on topics in logic with 44 junior college students. A version of the program providing confirmation after each item was contrasted with one which presented the same items of information one at a time in statement form, and with one which presented the same information in paragraph form allowing review. Though the two "prompted" versions took less time to complete than the confirmation version, there were no differences among groups on post-test scores.

Herschberger (1965) used lessons resembling programs and studied the effect of typographical cueing on learning. The essential material, tested by the criterion test, was prompted by underlining, size of type, and color. This type of prompting failed to increase learning though a related study (Herschberger, 1963) found that a simpler form of typographical cueing, using only color, helped students learn more of the core content.

Some Effect

Wittrock and Twelker (1964) used program-like materials with 18 college students to teach ten ways to decipher coded statements. In this study, cited earlier in this paper, prompting consisted of seeing the

decoding rule with each problem. Confirmation involved S seeing the decoded sentence after attempting to decode the problem sentence. Scores on post-tests, retention tests and transfer tests were highest when prompts were given, about the same when prompts and KOR were given, lower when KOR alone was given and lowest when neither KOR nor prompts were provided. The authors conclude that KOR is effective but only when it is not redundant (i.e., KOR plus prompts was no more effective than prompts alone).

Anderson, et al. (1968) modified the Holland-Skinner psychology program for use with 108 high school teachers in an educational psychology course. The first 1,052 frames were used, with one additional prompt added to about 5 % of the frames of the "prompted" version. Time to complete the program and post-test scores were compared for the prompted and a non-prompted version. Ss in all groups could look at the confirmation on the page containing the next frame. Ss in the prompted version took significantly less time and produced lower test scores. The authors suggest that there is a limit to the efficacy of prompting, that limit having been reached with this kind of program.

The authors related their findings to two other bodies of research on prompting: Cook's work referred to earlier and Holland's research on "blackout ratios" (Holland, 1965). They propose that their findings complement Holland's contention that the response in a program must be contingent upon attention to critical material in the frame. Anderson states: "learning is reduced when the prompts are of such a nature that it is possible for the student to respond correctly without attending to the cues [p. 93]."

Although a study by LeFurgy and Sisserom (1968) does not utilize programmed material it seems highly relevant here. The authors utilized concept cards with geometric figures to teach 30 young girls the concept "the one with the most sides is the correct one." One group received confirmation of correct choices (actually, pressing a button) on acquisition trials. Another group saw a light go on in front of the correct figure on the card ("tromptina") then make a choice. A third group could decide on which procedure, prompting or confirmation, they would like to follow on each trial. No differences (trials to criterion, errors, time, etc.) were found among the groups during acquisition. However, the free choice group was superior on the generalization post-test and in their ability to verbalize the concept. The confirmation group did *least* well in both tasks. It is also interesting to note that (1) on the average Ss in the free choice group chose the prompting procedure on about 50% of the acquisition trials and (2) that they requested prompts with decreasing frequency as acquisition proceeded, providing a self-controlled vanishing procedure. This latter finding recalls the repeated suggestion that Ss may play different roles as acquisition proceeds.

Roundaine has investigated and discussed a variety of issues in the prompting and confirmation controversy. He strongly argues that the

importance of feedback clearly depends upon the adequacy of prior prompting. "With a well-prompted program of the Skinner type, students may frequently pay little attention to the confirmation/correction panel since the program is sufficiently well cued so that they are generally certain of the correctness of the response they have made [Lumsdaine, 1961, p. 490]." He further suggests, specifically, that "at any point during acquisition, the strength of unconditional cues or prompts provided to the learner should satisfy the dual conditions of being: (1) just sufficient to elicit the correct response, but (2) no stronger than is required for this purpose [Lumsdaine, 1961, p. 482]."

The point which emerged early in the paper seems to be strengthened and clarified with each additional section: if KCR can function as a reinforcer at all it is likely to do so under special conditions which involve low probability of correct response (or, conversely, high probability of error). Lumsdaine seems to be suggesting that the programmer produce materials which are delicately designed to "keep the student on the edge", barely cueing the correct answer.

Student Use of Feedback

One of the most obvious ways to discover the actual reinforcing effect of KCR would be to make it available to the learner and notice whether or not he takes advantage of its availability. If a reinforcer is defined as strengthening the response which precedes it, and if KCR is indeed a reinforcer, then the response of producing KCR should be at high strength. Or as Anderson (1967) puts it: "If an explicit 'observing response' were required of students in order for them to receive KCR, then the rate at which this observing response occurred would be by definition the measure of strength of KCR as a reinforcer [p. 149]."

Melching (1966) used a 364-frame linear program on magnetism with 17 enlisted Army personnel. All answers had been deleted from the program which was then administered individually to each student. Experimenter, sitting opposite S, provided feedback (the printed answer) upon request from S after each response. The learners requested feedback on about one-quarter of the frames. Percent requests by Ss ranged from 57% to 6%. The first conclusion, then, is that Ss make far less than total use of the opportunities to obtain feedback. A second finding was that Ss tended to request feedback much more often when they were wrong than when they had correctly responded. Low ability students (as defined by scores on a measure of "general intellectual ability") requested feedback about three times as often as high ability students. They also made about three times as many errors in the program.

A series of studies by Geis, et al. (1966) dramatically support Melching's findings. Several different programs were used with college students as Ss. The answer to each frame was either on the back of the card containing the frame, or, in some instances, was exposed when S removed a piece of masking tape. It was consistently found that

(1) On the average students checked far less than 100% of the answers, (2) Students varied from one to another on the percent of answers they checked (unreported data indicate that each S is consistent in his checking rate over a variety of programs), (3) Clear, significant and positive correlations were obtained between erroneous responding and checking. Thus, though the checking rates differed widely from student to student, with only a few exceptions, the probability of checking, regardless of base rate, is higher after a student has emitted an erroneous response than when he has been correct.

Anderson's comment on Melching's data holds for these findings as well: "...the only decent thing to do in the face of these data is to question the assumption that KCR is a reinforcer [Anderson, 1967, p. 149]." Nevertheless, that broad statement seems to require an amendment. Under certain circumstances, namely after an error has been committed, the probability of observing behavior is raised and, by Anderson's definition, the printed answer may be said to be reinforcing. (Little attempt has been made in this paper to answer the question: What is being reinforced by feedback? While the ill-defined term "learning" intuitively seems like the proper and relevant answer, "the response just previous to feedback" is less assailable. It is assumed that the observing response is somehow related to learning and to continued participation in the program, but the relationship is not clear.

Summary and Conclusions

Knowledge of results is most frequently cited as the reinforcer in self-instructional systems. The printed answer in a programmed text, for example, is supposed to reinforce the response the student emits previous to observing that answer. Some other possible reinforcers were briefly discussed in this paper before the literature on KOR in self-instruction was selectively reviewed. The review was organized as a search for evidence that KOR might appropriately be called a reinforcer. Studies comparing programs with and without feedback were examined; the weight of evidence from these global studies was that feedback did not enhance learning, as measured by immediate post-test scores or by retention tests. In at least one case there seemed to be a decrement in performance traceable to the presentation of feedback. One recent and sophisticated study (i.e., Anderson, et al., 1970) did show clear advantages for feedback and thereby implied that KOR may be a reinforcer.

Studies in which "schedules of reinforcement" were varied similarly failed to show effects that would be expected if KOR were acting as a reinforcer. (However, high error scores within the program are consistently noted when percent KOR is reduced.)

One major study involving delay of KOR (i.e., Meyer, 1960) did report the effect expected when delivery of a reinforcer is delayed. Other studies on delay do not replicate this finding.

Finer grained analyses of student behavior and KOR begin to reveal specific conditions under which KOR seems to be acting as a reinforcer.

A few studies scattered throughout the literature report on manipulation of subject and task variables and of kinds of feedback. The results of these and the results of studies in prompting vs confirmation and student-controlled feedback suggest, each in a different way, that KOK may well be a reinforcer when uncertainty, or confidence, or probability of emitting an incorrect response is high.

It is clear that the printed answer (or its analog in other media) is not globally and automatically a reinforcer. The review provides the springboard from which one might jump into broader questions such as how, when, and why information on one's own performance in a learning situation becomes reinforcing.

Footnotes

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